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Profile of Junior High School Students' Critical Thinking Skills in Answering Questions Related to Biological Concepts

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abstract

There are indication that the implementation of education in various places in Indonesia is still not optimally empowering students' critical thinking skills (CTS). The aimed of this quantitative study was about 1) to survey the CTS of junior high school students in the Malang, and 2) to know whether or not there were differences in CTS between students in different grades. The measurement of CTS in this study used an integrated critical thinking assessment of the essay test. Mean score and one-way ANOVA were used as data analysis techniques. The results concluded that 1) students' CTS in Malang were still low; and 2) there was no significant difference in the level of CTS between students of class VII, VIII, and IX.

1. Introduction

Critical thinking skills (CTS) are one of the main competencies in various curricula which are also mentioned in various educational frameworks (Binkley et al., 2012; Learning Metrics Task Force, 2013; Levin-Goldberg, 2012; Moser, 2017). Most schools in various countries encourage the practice of empowering CTS as part of their science education (Donald, 2012). The reason, this skill is considered as one of the most important skills in the 21st Century era. Therefore, various educational institutions are targeting to be able to produce critical thinker graduates.

Critical thinkers refer to individuals with competence of revealing the root of problems that exist by seeking reasonable solutions (ŽivkoviĿ, 2016). Critical thinkers are also well-trained to evaluate, analyze, and interpret the information they have received (Ali, 2016). By means of such critical thinking, students are capable of solving any unusual problems that they might encounter, especially in these economic and global situations that remain unstable, today (Sundell, 2015). Additionally, individuals with critical thinking skill are deemed much easier and flexible to adapt and overcome any situations where information seems to develop very

fast (Dwyer, Hogan, & Stewart, 2014). Critical thinking skill also helps students cope with numerous challenges that somehow occur in their personal and career life in the future (Evens, Verburgh, & Elen, 2013). For that reason, empowering critical thinking skill will get students prepared to deal with unpredictable development as it happens today (Scott, 2015).

However, as with other higher-order thinking skills, empowering students' CTS is a challenge for teachers (Schmaltz, Jansen, & Wenckowski, 2017). The challenge becomes even more difficult because, for most students, efforts to improve CTS are not only an obstacle but can be intimidating to overwhelming (Crowley, 2015). Poor metacognitive skills, fixed mindset, various skills that cannot develop automatically, and students' assumption that thinking is a laborious activity are some of the barrier factors for students to develop their CTS (Persky, Medina, & Castleberry, 2018). The challenge will be even greater if the concepts taught are considered difficult by most students.

Several studies report that biological concepts are considered difficult by most middle school students. Various factors were informed to be the cause of this condition. Some of these factors include the nature of biological concepts that are abstract and complex (Murray-Nseula, 2011), the number of facts and concepts that must be understood (Almroth, 2015; Çimer, 2012), the lack of learning resources (Etobro & Fabinu, 2017), the rarity of practicum activities, misconceptions from textbooks or teachers (Yates & Marek, 2014), as well as the many foreign terms that students must know (Tekkaya, Ozkan, & Sungur, 2001). Difficulties in learning many concepts of biology are probably could to inhibit students to critically solve various biological problems. Because, the basis of a student being able to think critically is if he is able to understand the concepts learned

Responding to challenges in empowering CTS, curriculum and teachers must design a learning process that is able to optimally empower students' thinking skills. Unfortunately, the understanding and awareness of the importance of empowering higher-order thinking skills by Indonesia teachers are still uneven (Ramdiah, Abidinsyah, Royani, & Husamah, 2019). In addition, teacher knowledge about the implementation of thinking skills-based learning is also still in the low category (Retnawati, Djidu, Kartianom, Apino, & Anazifa, 2018). This information is in line with the results of observations conducted in various secondary schools in Malang. The observations were carried out during June to July in several schools which are partner schools of apprenticeship programs at the University of Muhammadiyah Malang, several schools in Malang City which are partners of the "Assignment of Lecturers in

Schools" period of 2019, and several public and private school in Tumpang sub-district, Malang. The observation concluded that most schools still tend to implement conventional learning, rather than learning with certain models whose benefits have been proven. This condition causing the empowerment of CTS in Indonesia is still not optimal.

A study that examines the profile or distribution level of students' CTS in Indonesia needs to be conducted. Such studies will provide information about the quality of education provision from the empowering thinking skills perspective. Some previous studies have attempted such a study. Some of these studies generally involve college (Amin, Corebima, Zubaidah, & Mahanal, 2017; As'ari, Mahmudi, & Nuerlaelah, 2017; Fitriani, Asy'ari, Zubaidah, & Mahanal, 2018.) and high school students (Elisanti, Sajidan, & Prayitno, 2018; Santika, Purwianingsih, & Nuraeni, 2018; Suyamto, Masykuri, & Sarwanto, 2018; Utami et al., 2018) as the subject of their research.

From various studies have been conducted, studies conducted at the junior high school level are still rarely found. In addition, research that seeks to access changes in student CTS levels based on class level also needs to be conducted in Indonesia. Such research will be one of the bases for evaluating the implementation of the 2013 Curriculum which actually has been designed to be able to empower the 21st Century skills of students. Therefore, this kind of research is still urgent to be carried out as an effort to monitor the level of Indonesian students' thinking skills empowerment from one year to the next. Thus, in this study, the profile of CTS of junior high school students in Malang was studied.

This research has several things that distinguish it from previous studies. First, this study involved a larger number of research samples than a sample of some previous studies. Second, the scope of this study not only informs the profile of students at one grade but from the all grade in junior high school. Thus, the information about the increasing of critical thinking level of junior high school students from one grade to the next grade can be obtained. In addition, this study also used a different instrument for obtaining students' critical thinking level. Furthermore, relating to what has been previously explained, students 'difficulties in learning Biology are indicated could to inhibit students' ability to solve various biological problems critically. Therefore, this study just focuses its scope on CTS students in solving Biology problems. The findings in this study can be the information for high school Biology teachers when designing CTS-based learning after reviewing the CTS profile of junior high school students which reported from this study.

2. Methods

2.1 Research Design

This quantitative research aimed at conducting survey on the CTS of junior high school students. The study was conducted from June to March 2019 with the subject of the study involving junior high school students in the Malang, Indonesia. The research began with the development of an instrument consisting of question items that are able to access students' CTS. Furthermore, the question instrument was validated by material and learning evaluation experts. Furthermore, the analysis of items was carried out after the instrument was implemented in 89 junior high school students. The data collection process was carried out by conducting tests using question instruments in schools that have been randomly selected. After that, the level of critical thinking for each sample was determined based on their answers.

2.2 Participants

The population of this study was all junior high school students in Malang, while the study sample was 209 students. In more detail, the sample consisted of 82 VII grade students, 61 VIII grade students, and 66 IX grade students who were randomly selected from four schools in the Malang region. These four schools consisted of two public schools and two private schools and in this study were labeled as school A, school B, school C, and school D. The four schools selected were schools that are in a moderate position (neither the highest nor lowest ranking academic school). The selection of these four schools was expected to provide an overview of the level of CTS that can represent the Malang student population in general. In addition, the presence of both public and private schools' representatives will provide general information regarding CTS in Malang, which is not limited to one type of school.

2.3 Data Collection Instrument

The data in this study were obtained using an integrated critical thinking assessment of the essay test. The instrument test was composed of 10 items. All question items were valid (Pearson Correlation <.05) and the question instrument was a reliable instrument (Cronbach's alpha = .471). The scope of biological concepts asked through these instruments, i.e. (1) the role of biology in human life; (2) the relation between biology with other branches of science; (3) scientific methods; (4) cell as the smallest unit of life; (5) the level of organization of life; (6) the role of viruses in human life; (7) the component of ecosystem; (8) characteristics of fungi and plants; (9) biodiversity as evidence of evolution; and (10) nutrition for human life.

In more detail, all questions used as instruments for collecting data in this study can be seen at Fauzi (2018).

2.4 Data Analysis and Interpretation

Student answers were assessed using critical thinking assessments developed by Zubaidah, Corebima, & Mistianah (2015). Then, student scores were analyzed using descriptive statistics and analytical statistics. First, the average test scores of students at each grade level were calculated as descriptive statistics techniques. Furthermore, data on students' CTS were tested for normality and homogeneity using the Shapiro-Wilk test and Levene's test, respectively. If the data were normally distributed and the variance between groups is homogeneous, then the data is analyzed using one-way analysis of variance (ANOVA). This analysis was conducted to determine whether there were differences in the CTS of students with different grade levels. The Least Significant Difference test was chosen as a post hoc test if the ANOVA test results informed there were any differences in the level of CTS between students who were at different grade levels ($\alpha = 0.05$).

3. Results and Discussion

CTS are expected to grow as students experience education. The comparison of the CTS among students from different grade level is presented in Figure 1. Based on Figure 1, it can be seen that CTS of seventh-grade students have the lowest mean score (28.10 ± 6,493), then followed by eighth grade (28.20 ± 6,237), while ninth-grade students have the highest mean score (29.97 ± 7,714). All of these mean scores is still in the low category. The low of students' thinking skills obtained in this study are in line with findings reported in several previous studies. Some of these studies such as research conducted by Fuad, Zubaidah, Mahanal, & Suarsini (2017), Elisanti et al. (2018), Suyamto et al. (2018), and As'ari et al. (2017).

Furthermore, the results of the *Shapiro-Wilk* test and the *Levene's* test inform that the data obtained from CTS was normally distributed (p-value = .056) and the variance between groups was homogenous (p-value = .060). A summary of the one-way ANOVA test results is presented in Table 1. Based on Table 1, the CTS between students of class VII, VIII, and IX were not significantly different [F (2, 206) = 1.623, p = .200; ηp^2 = .016]. These results indicate that the empowerment of CTS of junior high school students does not improve even though their class levels increase.

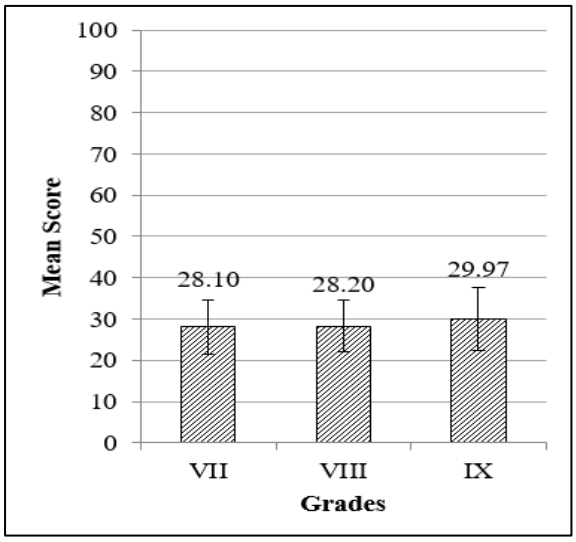

Figure 1. The comparison of CTS mean score of class VII, VIII, and IX

Table 1. Summary of ANOVA test results on the influence class level on students' CTS

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	ηp^2
Grade	151.546	2	75.773	1.623	.200	.016
Error	9616.798	206	46.683			

The main reason causing the low CTS which were informed from this study are due to internal factors of the students themselves. One of these factors is the lack of ability to face higher order thinking skills questions by majority of students. As a result, students are less accustomed to using their thinking skills. Consequently, students feel shocked when they were asked to answer questions that ask them to analyze or evaluate a problem. This statement is reinforced by a study informing that Indonesian students find difficulty to solve high-level thinking questions (Hadi, Retnawati, Munadi, Apino, & Wulandari, 2018). The main cause of these conditions is the lack of opportunities to answer such questions in the learning process (Netri, Holiwarni, & Abdullah, 2018).

In addition, the difficulties of students in mastering Biology concepts are also internal factors causing the low profile of students' CTS. Some of the concepts asked in the instrument used in this study ask some concepts that are perceived difficult by students. Some of these concepts include concepts about cells (Melati, 2016), viruses (Hasibuan & Djulia, 2017), and fungi (Hasruddin & Putri, 2014). Difficulty in understanding certain concepts is a barrier for someone to solve problems critically related to the concept. Moreover, the motivation of most Indonesian students often decreases when they are faced with difficult concepts. Whereas, student motivation also has a role in influencing the findings of this study. Motivation is a factor considered as the main driving force of academic achievement (Sharma & Sharma,

2018). Motivation is also considered to be the main factor for students to pursued themselves become critical thinkers (E. Lai, 2011).

Howsoever, the lack of CTS development of junior high school students revealed in this study is contradictory to science learning which is naturally able to encourage students to improve their thinking skills. However, the optimal empowerment of students' CTS in science learning is determined by the learning process designed by the teacher. Learning design that implements appropriate strategies or learning models will be able to facilitate students accustomed to thinking critically. Some forms of learning that are reported to be able to empower students' CTS, for example, is learning that directs students to solve problems (Bethel, Bernard, Abrami, & Wade, 2018; Oliveira et al., 2016), direct students to face authentic problems and situations (Abrami et al., 2014), and direct students to conduct a scientific process (Schmaltz et al., 2017).

Unfortunately, some science teachers in Indonesia have not consistently applied to learn models or strategies in the class they are teaching. Many teachers in Indonesia are even less familiar with various forms of innovative learning (Ramdiah et al., 2019). In fact, the results of the study Irawan, Rahardjo, & Sarwanto (2017) report that teachers still do not implement the learning that empowers students' CTS. In addition, teacher knowledge about how to design and implementing the assessments that are able to access students' thinking skills are also still low (Retnawati et al., 2018). Therefore, in order to improve the empowerment of CTS in secondary schools, teachers are expected to be able to recognize, master, and become accustomed to implementing learning activities and learning assessments that are reported to have a positive impact on students' CTS.

In addition, teachers are expected to be accustomed to applying learning assessments that support critical thinking habits. In preparing such an assessment, the teacher must use the open-ended question. Item questions are also expected could direct students to deal with contextual problems that require students applying the knowledge they have learned during the learning process (E. R. Lai, 2011). The form of assessment will lead students to get used to giving logical arguments to support the answers they express.

Furthermore, teacher awareness of the importance of CTS for students plays an important role in empowering these thinking skills during the learning process. Through this awareness, the learning process is not only oriented solely to test scores. The view that considers good learning is learning that directs students to memorize many new concepts also need to be

abandoned. This is a particular challenge if the form of learning evaluation still only accesses students' lower-order thinking skills. This condition will indirectly dictate the teacher to embroider the students to only master low-level knowledge. As a result, there is less time allocation for students to master high-level thinking skills.

Furthermore, a person will have difficulty when they should teach competencies that they do not master. Similar conditions are also drawn when the teacher tries to empower students' CTS during the learning process. Teachers who don't have critical thinking skill will find difficulties when they try to teach these skills to their students. Unfortunately, some researchers have reported that prospective teachers in Indonesia are still not critical thinkers. One study report that prospective mathematics teachers in Indonesia have not good CTS (As'ari et al., 2017). Other study involving prospective biology teachers as the subject of their research also informed similar findings (Slamet, Tapilouw, Rohman, & Adianto, 2014). Therefore, training programs aimed at improving teacher competency, especially the competence to design CTS-based learning need to be conducted by the Indonesian government (Slameto, 2014).

The habit of thinking critically is not a blessing, but it can be developed through the educational process (Heijltjes, 2010). This was confirmed by Wang & Zheng (2016) which also states that CTS are skills that can be taught. Therefore, if the design of learning and assessment of learning in junior high schools can be designed based on CTS, the students' CTS will be more and more along with the length of their education. Preparing prospective teachers as critical thinkers is one of the main keys to the success of empowering thinking skills in the administration of education. In addition, the government must also play a role in increasing teacher awareness regarding the importance of empowering thinking skills in the learning process to face challenges in the 21st Century.

However, this study has several limitations that can be a concern for future research. One of the limitations is that students' CTS profiles were only measured using one type of instrument. In further research, the use of various CTS instruments is recommended. Besides having never been done in various CTS studies, the findings obtained from this kind of research will provide students' CTS profile from a broader and general perspective. Another limitation in this study is the selection of samples that only come from moderate school. Research that examines the profile of CTS with not only involving a large number of samples

(such as this present study) but also involves both high and low academic ability schools will be provide an overview about the influence of the academic level on student CTS levels.

4. Conclusion

This study shows that the CTS level of students in Malang is still not well empowered. In addition, the findings of this study also informed that there were no significant differences in CTS between students with different grade levels. The results of this study indicate that the class level does not have a significant impact on the CTS of middle school students. Therefore, the application of learning strategies that are proven to improve critical thinking skills is recommended to be consistently carried out in various science learning in Indonesia. Because, the low CTS of students probably indicate that science learning in schools is still not optimally implementing a learning process that could empower students' CTS.

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